

Figure 1A
(Prior Art)

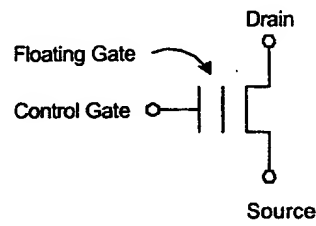


Figure 1B
(Prior Art)

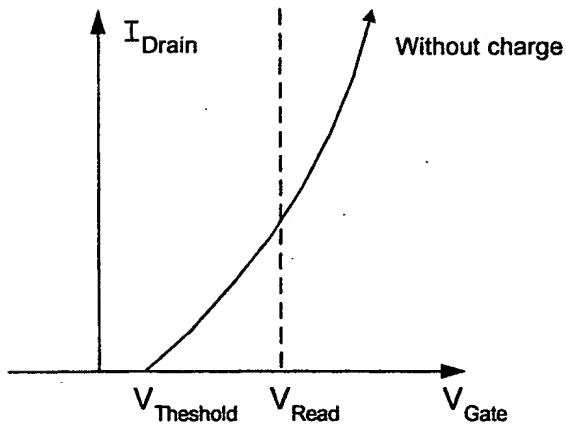


Figure 1C
(Prior Art)

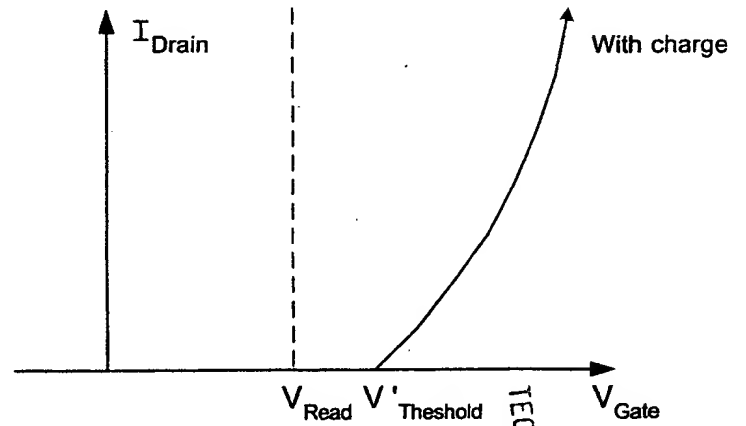


Figure 1D
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Calculation of nv memory cell retention characteristics

q0, C 1.6022E-019 m0, kg 9.1095E-031 kb, J/K 1.38062E-023 h, J-s 6.62617E-034 hb, J-s 1.054588E-034
b0, eV (barrier) ϵ 2.9 mr, effective mass ratio 3.9 0.5 T, K degree 300
C 1.0630E-006 b 2.3854E+008

Seconds
31536000
94608000
1.89E+008
2.84E+017
3.78E+008
4.73E+008
9.08E+009
6.62E+008
7.57E+008
8.51E+008
9.46E+008

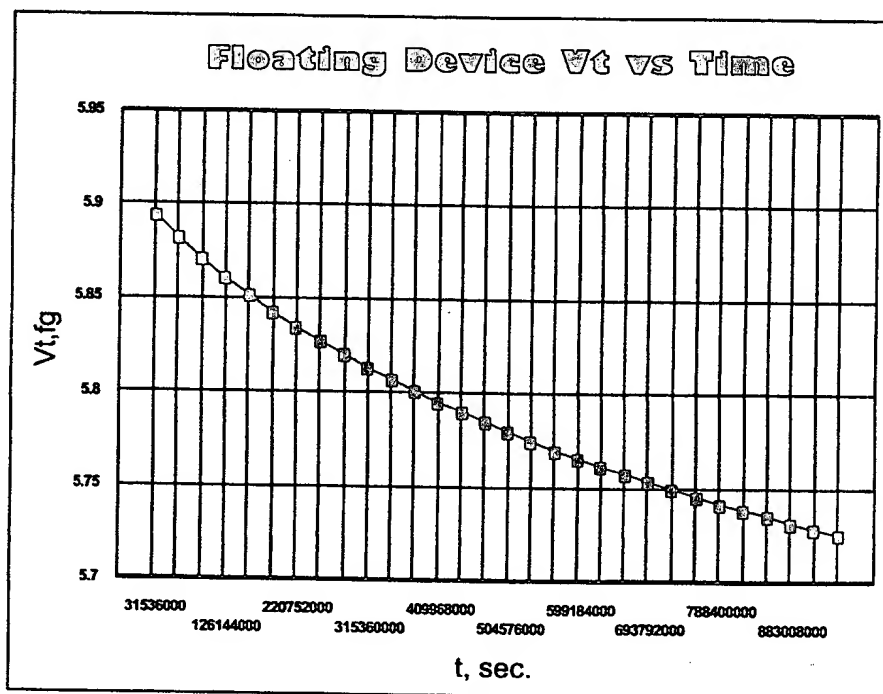
Time Period
1 year
3 years
6 years
9 years
12 years
15 years
18 years
21 years
24 years
27 years
30 years



Lfg um 0.6000
Wfg um 1000.0000
Hfg um 0.0900
Wrx um 0.5000
Ttunox A 80
Tono A 190
Tswox A 300
Xfd um 0.0500
Xfs um 0.3500
Ainj um2 0.0438
Cfc fF 1089.5358
Cfsx fF 0.4313
Cfd fF 0.1078
Cfs fF 0.7547
Cfg fF 1090.8295
Cr,wl 0.9988
Cr,src 0.0007
Vt,fg V 0.90
Verase 0.00
Vfg,ini -5.00
Va 0.00
S 3.76E+016
X 1.27E+011

Channel length of floating gate device
Channel width of floating gate device.
Thickness of floating gate polysilicon conductor
Width of floating gate overlapping shallow trench isolation
Tunnel oxide thickness
Thickness of Oxide-Nitride-Oxide dielectric between floating gate and control gate for capacitive coupling
Thickness of sidewall oxide between floating gate and control gate for sidewall coupling
Length of floating gate overlapping drain region of the floating gate MOSFET
Length of floating gate overlapping source region of the floating gate MOSFET
Area of the electron tunneling region between the floating gate and the source for resetting the floating gate charge
Capacitance between the floating gate and the control gate
Capacitance between the floating gate and the silicon substrate
Capacitance between the floating gate and the drain
Capacitance between the floating gate and the source
Total floating gate capacitance
Control gate to floating gate coupling ratio
Source junction to floating gate coupling ratio
Threshold voltage of floating gate MOSFET
Erase voltage applied to the source(not used here, set to zero)
Initial floating charged voltage
Actual erase voltage (equal to applied + charge stored on the floating)
Derived parameter in the floating gate "erase" equation
Derived parameter in the floating gate "erase" equation

t, sec. Vt,fg
0.00001 5.907
31536000 5.894
63072000 5.882
94608000 5.871
1.26E+008 5.861
1.58E+008 5.852
1.89E+008 5.843
2.21E+008 5.835
2.52E+008 5.827
2.84E+008 5.820
3.15E+008 5.814
3.47E+008 5.807
3.78E+008 5.801
4.1E+008 5.795
4.42E+008 5.790
4.73E+008 5.785
5.05E+008 5.780
5.36E+008 5.775
5.68E+008 5.770
5.99E+008 5.766
6.31E+008 5.762
6.62E+008 5.757
6.94E+008 5.753
7.25E+008 5.750
7.57E+008 5.746
7.88E+008 5.742
8.2E+008 5.739
8.51E+008 5.735
8.83E+008 5.732
9.15E+008 5.729
9.46E+008 5.726



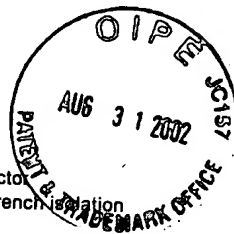
Figures 1E-1F
(Prior Art)

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Calculation of nv memory cell retention characteristics

q0, C	m0, kg	kb, J/K	h, J-s	hb, J-s	Seconds	Time Period
1.6022E-019	9.1095E-031	1.38062E-023	6.62617E-034	.....	60	1 minute
					3600	1 hour
b0, eV (barrier) e1	mr, effective mass ratio		T, K degree		86400	1 day
2.9	3.9	0.5	300		604800	1 week
					2592000	1 month
C	b				.....	1 year
1.0630E-006	2.3854E+008				.....	4 years
					.....	16 years
					.....	32 years



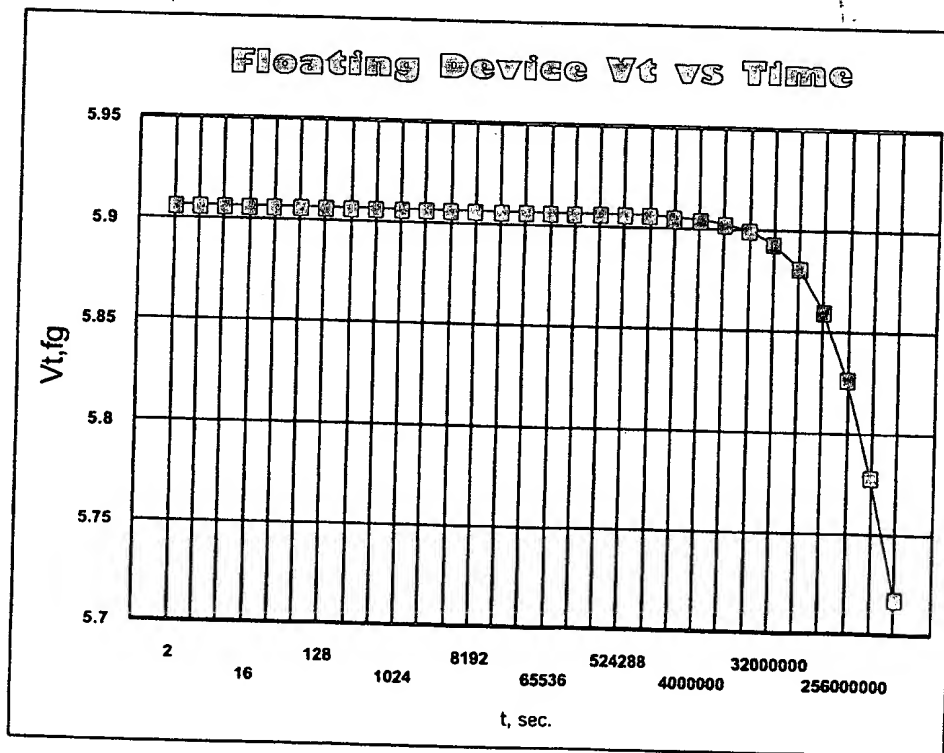
Lfg um 0.6000 Channel length of floating gate device
 Wfg um 1000.0000 Channel width of floating gate device.
 Hfg um 0.0900 Thickness of floating gate polysilicon conductor
 Wrx um 0.5000 Width of floating gate overlapping shallow trench isolation
 Ttunox A 80 Tunnel oxide thickness
 Tono A 190 Thickness of Oxide-Nitride-Oxide dielectric between floating gate and control gate for capacitive coupling
 Tswox A 300 Thickness of sidewall oxide between floating gate and control gate for sidewall coupling
 Xfd um 0.0500 Length of floating gate overlapping drain region of the floating gate MOSFET
 Xfs um 0.3500 Length of floating gate overlapping source region of the floating gate MOSFET
 Ainj um2 0.0438 Area of the electron tunneling region between the floating gate and the source for resetting the floating gate charge
 Cfc fF 1089.5358 Capacitance between the floating gate and the control gate
 Cfsx fF 0.4313 Capacitance between the floating gate and the silicon substrate
 Cfd fF 0.1078 Capacitance between the floating gate and the drain
 Cfs fF 0.7547 Capacitance between the floating gate and the source
 Cfg fF 1090.8295 Total floating gate capacitance
 Cr,wl 0.9988 Control gate to floating gate coupling ratio
 Cr,src 0.0007 Source junction to floating gate coupling ratio
 Vt,fg V 0.90 Threshold voltage of floating gate MOSFET
 Verase 0.00 Erase voltage applied to the source(not used here, set to zero)
 Vfg,ini -5.00 Initial floating charged voltage
 Va 0.00 Actual erase volatge (equal to applied + charge stored on the floating)
 S 3.76E+016 Derived parameter in the floating gate "erase" equation
 X 1.27E+011 Derived parameter in the floating gate "erase" equation

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t, sec.	Vt,fg
0.00001	5.907
2	5.907
4	5.907
8	5.907
16	5.907
32	5.907
64	5.907
128	5.907
256	5.907
512	5.907
1024	5.907
2048	5.907
4096	5.907
8192	5.907
16384	5.907
32768	5.907
65536	5.907
131072	5.907
262144	5.907
524288	5.907
1000000	5.907
2000000	5.906
4000000	5.905
8000000	5.904
16000000	5.900
32000000	5.894
64000000	5.881
.....	5.860
.....	5.827
.....	5.779
.....	5.718



Figures 1G-1H
(Prior Art)

Calculation of nv memory cell retention characteristics

q0, C m0, kg kb, J/K h, J-s hb, J-s
1.6022E-019 9.1095E-031 1.38062E-023 6.62617E-034

b0, eV (barrier) ϵ 1 mr, effective mass ratio T, K degree
2.9 3.9 0.5 300

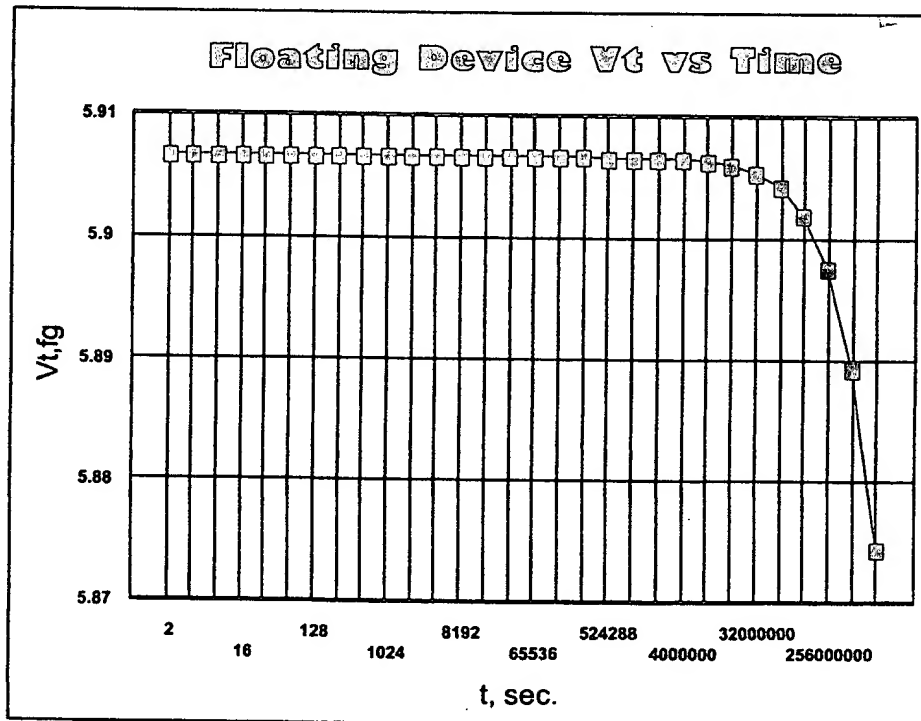
C b
1.0630E-006 2.3854E+008

Seconds Time Period
60 1 minute
3600 1 hour
86400 1 day
604800 1 week
2592000 1 month
..... 1 year
..... 4 years
..... 16 years
..... 32 years



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Cfsx fF 0.4059 Capacitance between the floating gate and the silicon substrate
Cfd fF 0.1015 Capacitance between the floating gate and the drain
Cfs fF 0.7103 Capacitance between the floating gate and the source
Cfg fF 1090.7534 Total floating gate capacitance
Cr,wl 0.9989 Control gate to floating gate coupling ratio
Cr,src 0.0007 Source junction to floating gate coupling ratio
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X 1.20E+011 Derived parameter in the floating gate "erase" equation

t, sec.	Vt,fg
0.00001	5.907
2	5.907
4	5.907
8	5.907
16	5.907
32	5.907
64	5.907
128	5.907
256	5.907
512	5.907
1024	5.907
2048	5.907
4096	5.907
8192	5.907
16384	5.907
32768	5.907
65536	5.907
131072	5.907
262144	5.907
524288	5.907
1000000	5.907
2000000	5.907
4000000	5.906
8000000	5.906
1.6E+007	5.906
3.2E+007	5.905
6.4E+007	5.904
.....	5.902
.....	5.898
.....	5.889
.....	5.874



Figures 11-1J
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